# *Darwin – Dean Geoffrey*

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***Speaker: Dean Geoffrey***

Dean Geoffrey: My name is Dean Geoffrey and I'm from Sydney, from the University of New South Wales-

Hon. Justice Pepper: Thank you.

Dean Geoffrey: ... but not officially representing them.

Hon. Justice Pepper: Thank you.

Dean Geoffrey: I've just written an essay. Good afternoon ladies and gentlemen of the Inquiry into fracking of unconventional aquifers in the Northern Territory. The title of this essay is entitled Hydraulic Fracturing, a Generational Problem. I'll start this speech by stressing the word aquifer as stated in the title of the Inquiry. Now, I'm a graduate engineering student of the University of New South Wales, I have a Bachelor in Environmental Engineering and a further graduate diploma studying the fields of hydrogeochemistry, hydrogeochemical modelling, and ground water contamination.

Now, you may ask what is hydrogeochemistry and how do you model that? Well quite simply put, as the name suggests, hydrogeochemistry is the study of the chemistry of the hydrological layer within the geology of the earth. In other words the careful study of how the water in aquifers have achieved their distinct chemical composition which often takes millions of years. The delicate chemistry of the aquifers and spring water, especially in a place as untouched as the territory are an achievement, a process of settlement which has taken millions of years in the making.

What hydraulic fracturing aims to achieve is the division of this chemistry, this harmony, this geology, a division of the landscape, a division of race, generation, and class. They say it will be safe but nobody really knows. Fracking involves drilling deep wells vertically through many layers of rock and then drilling horizontally, and then at high pressure a mixture of water, sand, and chemicals are forced into the ground to crack the rock and enable gases to rise and find their way to the surface.

To reach the gas and shale rock a wellbore is sunk thousands of feet into the earth passing through different strata including freshwater aquifers,

sandstone, and siltstone, down to the shale or coal beds. To access these fossil fuels thousands of gallons of water with chemicals and silica is blasted horizontally into the layer and a pressure so high it could chip the paint off a car, a process called hydraulic fracturing.

Now, what a lot of investigation into the effects of hydraulic fracturing fails to do is to look into this effect on the groundwater table, and more importantly the chemical composition of ions at varying depths within the groundwater layers. You see, each metre below the surface the aqueous chemistry is always different from the metre that proceeded it. There is a very delicate balance of carbonates, sulphates, nitrates, oxygenated ions, and ions as metals including magnesium, calcium, iron, copper, zinc, to name a few. All of which rise to the surface through natural springs, which in turn nourish the biology on the surface which is not just us humans.

Now, as one would assume with such a complex matrix of carbonates and metallic ions underground, surely harmful ions exist in the groundwater table too, and yes, of course this is the case. At lower depths, trapped in denser geological layers, we find the heavier metallic ions such as cadmium, lead, mercury, barium, and semi-metals such as arsenic. Now, what hydraulic fracturing inevitably does is create definable pathways for these different minerals and ions to travel and mix via disrupting the natural in situ state of the groundwater and geological layers. It does this even in the original drilling stage.

I haven't even mentioned the risks of pouring persistent chemicals and biocides at high pressure into a well, which cuts through various aquifers of pristine water. No, I'll start by just talking about the contamination that can occur by simply drilling a hole. Even connecting aquifers near the surface with the chemicals at lower depths can easily lead to arsenic poisoning of a groundwater table, please keep in mind in the Northern Territory all the aquifers lead to beautiful natural springs, which I myself enjoy the rejuvenating effects of due to the delicate chemistry of minerals in the water.

Now, arsenic contamination of groundwater is due to naturally occurring high concentrations of arsenic, in the deeper levels of groundwater, and when this is seeped into the more accessible layers of the aquifer. In 2007 a study found that more than 70 countries have been affected by arsenic poisoning of drinking and groundwater due to deep boring of wells. Water contaminated with arsenic typically contains arsenic acid in its derivatives. The aquifers and therefore the spring water is contaminated when these compounds are extracted from the underlying rocks that surround the aquifer. Arsenic acid tends to exist as oxygenated ions, and arsenous acid is not ionised. Here we can see the complexity of the presence of only one noted naturally occurring metallic ion and its allotropes within the ground layers and is the effect on biodiversity.

Just how easy are aquifers to contaminate? Well I'll refer to a recent article from Katherine Gregory at the ABC. The Department of Defence has released a report into the water quality of 12 sites around Australia located

near contaminated Royal Australian Air Force bases. It is the second major round of investigations into the impact of the chemicals used in fire retardants at the bases. It comes long after residents in two Queensland towns were alerted to significant contamination of their groundwater, and 12 RAAF sites around Australia with the toxins Perfluorooctanesulfonic acid and Perfluorooctanoic acid used on the bases have eventually seeped into the groundwater. The preliminary sampling report looks at the residential groundwater and surface water at those sites and have found hazardous chemicals at levels exceeding safe environmental guidelines. The report shows groundwater or drinking water at the bases in Townsville, Garden Island, the West Australian coast, and Tindal near Katherine to exceed those levels. "It is a painstaking process to work out the potential of these chemicals," said Mr. McVay. 400 residents have launched a class action against defence because of declining property values in Queensland.

Again, this is caused by one or two chemicals that we released into the atmosphere. We're talking about fracking fluids, we're talking thousands of chemicals. We're talking toluene, benzene, you name it. Yeah, that was caused by just one or two chemicals. I was astounded upon arriving here in the NT for the second time, I was here 10 years ago with my father, and I learnt now that I can't go fishing and catch a barramundi in the Katherine River and eat it because it's poisoned, whereas I could do that 10 years ago with my father, but I can't do it with my son now.

Now, in understanding the fact that the geography of the Northern Territory is such that its aquifers are large, they are near the surface, they feed springs and natural rivers across the state. Also, noting the fact that certain factors such as size, interconnectivity, porosity, saturation levels, chemical composition, are all things which determine the flow rate in the groundwater underneath our feet. A recent report in the last issue of C-Tech Globe indicates that fracking seems to be associated also with elevated levels of arsenic in groundwater.

Now, creating large amounts of pressure underneath aquifers push heavy metals that have settled over millions of years, as well as methane gases and the synthetic chemicals used for lubrication in fracking, into waterways underneath the earth, which have been protected for millions of years, while destabilising the fragile subterranean landscape. Now, there are also many engineering factors that affect the safety of a well, with geology is just one of them. Porosity, permeability of the groundwater table, and not to mention the elevated pollution levels in rivers and streams because wastewater treatment facilities cannot cope with the disposal of used hydraulic fracturing fluids, as we've seen in the Pilliga State Forest, where they are releasing it back into the environment now.

Another point to consider is the social conflictivity that fracking is awakening in several parts of the nation and the globe, and also the right for local population to maintain their traditional way of life and recognise their duty to protect the land as did their ancestors. If the argument is stability of gas supplies in this country, I refer to a line from the AWU National Secretary, Daniel Walton, who said it was, "A disgrace ordinary families were being lied

to simply because the federal government is too gutless to pull a handful of multinational gas exporters back into line." By allowing exporters to ship Australia's natural gas to foreign markets without restriction, the federal government is hammering average working families from multiple angles, hence the position that we need this to secure our gas futures, when, as I've stated, a lot of that is controlled by gas exports. There really is no need to unconventionally fracture this pristine landscape, it merely does come down to short-term profits, and that's pretty evident.

I remember at other sites around this nation and across the world, high concentrations of methane and ethane in drinking and surface water in close proximity to wells. A recent study has found that under certain conditions the chemical laced water used in hydraulic fracturing can migrate through fractures and faults up to overlying aquifers in as little as 10 years. The study done by hydrogeologist, Dr. Tom Myers and published in the peer reviewed Groundwater, raises renewed questions about the potential for hydraulic fracturing to fundamentally alter shale rock formations and the hydrogeologic cycle in ways that could affect freshwater drinking supplies.

There are not only concerns, there's evidence that improperly sealed, unsealed, or abandoned drilling wells, as well as naturally occurring fractures and faults offer a path to connect gas bearing shale layers with overlying freshwater aquifers. A common response by the oil and gas industry to this concern is that upward migration of deep thermogenic methane gas and chemicals used in the fracturing process is impossible due to layers of impermeable rock that prevent such movement. The problem is the industry offers little to no data to support this argument. While the ability of shale to transmit fluids, noting its permeability, is about 1000 times less than that of sandstone, the entire process of hydraulic fracturing is to increase the permeability of these rocks to allow gases and ions to travel easier upwards in direction of the pressure.

Paul Rubin, a hydrogeologist from the US said savvy companies often target such fractures and porous stones in the land. Gas companies are integrating preexisting fractures, when they put in horizontal drilling wells they go perpendicular to those fractures to maximise the number of fractures they go through and the gas potential. He states that the low porosity of the shale and coal beds themselves could accelerate this movement of fluids. Now, up to a third of the fluids used in hydraulic fracturing will resurface as naturally occurring and extremely salty brine or produced water, so a third of the water that goes in the ground will come back to the surface, two thirds will stay in the ground. The high amounts of the resulting wastewater from the fracturing process has raised its own challenges around disposal and treatment of water, as well as the potential for water contamination from spills. Essentially what we want to do is take the most pristine water out of the ground, mix it with chemicals, bring it back out of the ground and then store that on top of the land for the next large rain to come and spread it around.

Excuse me. It is the water underground that is my focus. Brine has been found more than 1000 metres above its evaporative source, suggesting

evidence of upward movement. The question is how quickly this movement occurs and how the fracking process might affect the rate. Dr. Myers, the same hydrogeologist states, "Fracking shale moves water that could meet up with naturally occurring fractures in sandstone and result in faster movement to the surface aquifers." To determine this, he created five conceptual models to test different parameters and the flow rate from the Marcellus shale project. These models deal with the natural upward movement of brine.

Under certain circumstances Myers found that the pressure induced by hydraulic fracturing combined with the changes to the fractured shale and the presence of a fault could mean that fluids migrate upward from shale to aquifers in as little as 10 years. Myers summarised his results, "You change the properties of the shale, you change the flow of the system. If the fractured shale between each of the wellbores almost connects, you end up with a system of several orders of higher conductivity, you end up increasing the flow rate."

Other hydrologists, like Rubin in the US, are concerned about not just fractures and faults, but the potential for water contamination through drilling well casing failures. "It is not if but when it will happen, and it will happen," he states. His studies have focused on documented cases of cement and steel casing problems, and the relatively short lifespans, usually 100 years, of the casings compared with the million year lifespan of the aquifers that they are supposed to protect. Well casing will degrade, and even if that does not end up being a problem, the fracturing process itself will result in cracking of the cement sheath. Also, a lot of these wells are in seismically active areas and ground motion and shaking will themselves crack the sheath.

In 2005 it was reported in a US EPA document with statements explaining that the fracking fluids migrated unpredictably through different rock layers and to greater distances than previously thought. In as many as half of the cases studied in the United States, it found that as much as a third of injected fluids, benzene in particular, remained in the ground after drilling and will likely be transported by groundwater. In several states where hydraulic fracturing is occurring many of the chemicals used and their concentrations remain unknown, protected through a legislation as propriety trade secrets. This legislation was later traced to a model bill sponsored by ExxonMobil.

Myers cautioned that until more data is collected on the way that hydraulic fracturing affects the hydrogeologic cycle, the process should not occur in sensitive or highly populated areas. The Northern Territory, ladies and gentlemen, is one of those sensitive areas. Rubin thinks that what is already known about well casing failures is enough to put a hold on unconventional drilling. Why would anyone risk our aquifers for a few years of profits?

Thank you very much for your time.

Hon. Justice Pepper: Thank you very much. Do we have any ... Yes, Professor Hart?

Prof. Barry Hart: Thank you for mentioning the Myers paper, we're well aware of that, it's referenced here. 2012, it's relatively old now in terms of where things have progressed. I want to ask you if you'd actually read the draft report?

Dean Geoffrey: I read it about a month ago, I've been working at sea the last three weeks.

Prof. Barry Hart: Okay, so you would've seen-

Hon. Justice Pepper: Good, thank you.

Prof. Barry Hart: You would've seen there that we did a heck of a lot of investigation, a lot of evidence in terms of the potential ... A number of the pathways you mentioned, we've analysed those. Leaky wells in particular, surface spills, possibility of interaction with faults. Do you agree or disagree with what we've put down?

Dean Geoffrey: I believe that unconventional fracking, as it stands, is highly unnecessary. I'm talking from a-

Prof. Barry Hart: That's different. That's different.

Hon. Justice Pepper: Hang on, just let him finish. Thanks.

Dean Geoffrey: I'm talking from a generation below, I was born in 1986, and when we look at the state of the world we believe that there's enough pollution, there's enough plastic in the ocean, there's enough poisoned rivers, there's enough of the Amazon that's been deforested. The way I see it, the only benefit in any of this is a short-term profit for some gas companies, there is no any other benefit across the state for the aboriginal communities, the Indigenous owners of the land, tourism operators. There's no benefit for anyone, for any life, plant, animal, human that enjoys swimming, there is no benefit other than a short-term profit.

The question I want to leave to you is this is really the last place in Australia ... I'm not from here, I'm from Sydney, and I've come to the Northern Territory for this reason, because it's a territory and because it's the final place where I believe Australia can make a stand and we can make our own rules and our own regulations. I've just seen it too many times that you say yes to fracking and a whole bunch of problems follow, because at the end of the day, what we're doing is we can predict it and put as many regulations as we want, but the very nature of what we're doing is blasting at high pressure, poisons into the ground, into the water table that find their way to the surface.

I don't see any reason, at all, why any sort of unconventional ... Unconventional is the main word, and we're dealing with a state which has a whole lot of porous, interconnected aquifers. We don't know who are these companies, are they Australian companies? Chinese companies? We're going to sell out the state just for a short-term profit, potential short-term profit. That's where I stand. I agree on the hard work you've done in the summary of the draft of the final report, but that's where I stand.

Prof. Barry Hart: No, that's fine. I totally accept your viewpoint, it was just that you're putting up a number of scientific comments there, and I'm asking you whether you've read our report. We spent months and months, we've been through every piece of evidence we could possibly find, so we're challenged with responsibility of using evidence. You're entitled, entirely entitled to your view, I just was a little concerned that you're wrapping it up in science without necessarily being able to say whether you thought we were right or wrong.

Dean Geoffrey: I'll take that on board sir.

Hon. Justice Pepper: Thank you. No further questions? Thank you very much Mr. Geoffrey, again, for being so patient and for presenting here today. Thank you.

Dean Geoffrey: Your welcome. Thank you very much for your time.